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Description

Method ~~and base station for channel allocation in a radio communication system~~

a. The present invention relates to a method and a base station for channel allocation in a radio communication system, ~~especially~~ particularly in a mobile radio system or wireless subscriber access system.

Description of the Prior Art

In radio communication systems, user data such as, for example, voice, picture information or other data ~~are~~ is transmitted between a transmitting and a receiving radio station via a radio interface with the aid of electromagnetic waves. Electromagnetic waves are radiated ~~by means of~~ via carrier frequencies which are in the frequency band provided for the respective system. In the known GSM (global system for mobile communication) mobile radio system known from, among others, J. Biala, "Mobilfunk und intelligente Netze" (Mobile Radio and Intelligent Networks) Vieweg Verlag, 1995, particularly pages 57 to 92, the carrier frequencies are in the range of 900 MHz, 1800 MHz and 1900 MHz. For further radio communications systems, for example the UMTS (Universal Mobile Telecommunication System) or other third-generation systems, frequencies are provided in the frequency band ~~of approx.~~ approximately 2000 MHz. To distinguish different signal sources at the location of the respective receiver, frequency division multiplex access (FDMA), time division multiple access (TDMA) and/or code division multiple access (CDMA) methods and combinations of these known methods can be used.

On page 78 of the abovementioned prior art by J. Biala of a GSM mobile radio system, it is disclosed that a mobile radio station, when setting up a connection, uses a special signaling channel RACH (Random Access Channel) for

requesting a transmission channel at a base station. To prevent blocking during simultaneous access of a number of mobile radio stations to this signaling channel, the access is effected in accordance with a temporal random access method. As acknowledgement to the connection request, the base station directly allocates a transmission channel on another signaling channel AGCH (Access Grant Channel) or refers to a specific signaling channel SDCCH (Stand-Along Dedicated Channel) for the further connection set-up procedure according to standard methods. The signaling channel AGCH is transmitted at the maximum transmitting power in each case by the base station.

A radio communication system exhibiting subscriber separation in accordance with a CDMA method is very sensitive to interference due to the transmitting power being too high due to simultaneous utilization of a frequency band by a multiplicity of subscribers.

The present invention is therefore directed to ~~based on the object of specifying~~ a method and a base station which enable transmission channels to be allocated to communication connections in a radio communication system which uses a CDMA subscriber separation method, without impairing the transmission quality. ~~According to the invention~~, this object is achieved by the features of the independent claims. Advantageous embodiments of the invention can be found in the respective subclaims.

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According to the present invention, in the method for channel allocation in a radio communication system which uses a CDMA subscriber separation method for transmitting information for communication connections via a radio interface between a base station and a radio station, the radio

station signals a request for a number of transmission channels for a communication connection in a signaling channel to the base station. Furthermore, the radio station signals additional information about measured transmission conditions of the radio interface in the signaling channel to the base station. This additional information is evaluated by the base station and taken into consideration for controlling a transmitting power for a further signaling channel for allocating the requested number of transmission channels to the radio station.

The present invention has the advantage that the base station can perform an estimate with regard to the transmitting power needed for the subsequently transmitted further signaling channel for allocating the requested transmission channels on the basis of the transmission conditions of the radio interface determined by the radio station. This regulation of the transmitting power advantageously reduces the interference effect of the further signaling channel of the conditions of reception of further receiving radio stations which operate a communication connection in the same frequency band.

According to two alternative embodiments ~~further developments~~ of the present invention, the radio station determines as additional information, on the one hand, a received level for a general signaling channel which is transmitted with a constant transmitting power by the base station and which contains general information on the radio communication system and, as additional information, on the other hand, at least one characteristic value which contains information on a received level, a bit error rate and/or a value proportional to the signal transit time between the radio station and the base station and/or a signal/noise ratio.

The radio station can determine the attenuation occurring during the transmission via the radio interface by measuring the received level since, as a rule, the radio station knows the transmitting power with which the general signaling channel is transmitted by the base station. The base station can determine the required transmitting power for the further signaling channel for allocation on the basis of this measurement. If the radio station determines a characteristic value having the specified parameters, the base station can advantageously perform a very accurate estimate with regard to the transmission ratios and correspondingly can accurately control the transmitting power for the further signaling channel for allocation. In both cases, any interference disturbances for parallel communication connections are reduced and the transmission quality is thus advantageously increased. Furthermore, the additional information can be subsequently ~~advantageously~~ used for controlling the transmitting power for the allocated transmission channels as a result of which the additional signaling expenditure is compensated for.

In accordance with a further development of the present invention, the radio station determines, and signals to the base station, a respective interference situation in time slots as additional information, a subscriber separation according to a TDMA method being additionally performed in the radio communication system according to a preceding further development.

According to ~~a further development~~ another embodiment of the present invention, the base station can take into consideration the additional information about the respective interference situation in the time slots for selecting at least one suitable time slot in which the requested number of transmission channels is allocated.

Due to these further developments, the base station can allocate the requested transmission channels by taking into consideration the interference conditions existing at the location of the radio station. As a result, the transmission quality is advantageously increased for the allocated transmission channels~~,~~ and, at the same time, there is less interference by the communication connection newly set up for communication connections operated in parallel in the same time slots. Thus, an advantageous allocation of transmission channels to radio stations is performed in such a manner that the most advantageous interference situation possible is given in the allocated time slot or time slots for the respective radio station.

Sub A3 ~~Exemplary embodiments of the invention will be explained in greater detail with reference to the attached drawings, in which:~~

Figure 1 shows a block diagram of a radio communication system, such as ~~especially~~ a mobile radio system~~.~~;

Figure 2 shows a diagrammatic representation of the frame structure of the radio interface and of the configuration of a radio block~~.~~;

Figure 3 shows a signaling diagram of the method of ~~according to~~ the present invention~~.~~; and

Figure 4 shows an expanded signaling diagram of the method of ~~according to~~ the present invention.

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The structure of the radio communication system shown in FIGURE ~~figure~~ 1 and designed as a mobile radio system, by way of example, corresponds to a known GSM mobile radio system which consists of a multiplicity of mobile switching centers MSC which are networked together and, respectively, establish access to a landline network PSTN. Furthermore, these mobile switching

centers MSC are connected to, in each case, at least one device for allocating radio resources RNM. Each of these devices RNM, in turn, provides for a connection to at least one base station BS. This base station BS is a radio station which can set up and release communication connections to mobile radio stations MS via a radio interface. The functions of this structure are used by the method according to the present invention. At the same time, use in, for example, a wireless subscriber access system (Access Network) is also possible.

Figure 1 shows, by way of example, two communication connections V1, V2 for transmitting user data and signaling information between two mobile radio stations MS and a base station BS, the communication connections V1, V2 in each case having being allocated a transmission channel RU which is defined by ~~in each case~~ one CDMA code C1 and C2, respectively. This corresponds to a known CDMA subscriber separation method. Furthermore, a further mobile radio station MS is located in the radio coverage area of the base station BS which has not yet set up a communication connection in the case represented.

According to a channel pooling method known from the article J. Mayer, J. Schlee, T. Weber "Protocol and Signaling Aspects of Joint Detection CDMA, PIMRC '97, Helsinki, 1997, pages 867-871, one or more transmission channels RU can be allocated ~~in each case~~ respectively to a communication connection, each transmission channel RU being distinguishable by an individual CDMA code c according to the CDMA subscriber separation method. The method of channel pooling is advantageously used for being able to implement communication connections to and from radio stations having different data rates or to be able to operate a number of services in parallel on one communication connection.

The base station BS exhibits a transceiver device SEE for transmitting and receiving user and signaling information in transmission channels RU and signaling channels . Apart from the transceiver device SEE and an evaluating device AW ~~according to the invention,~~ the operation of which will be described in the description relating to FIGURES ~~figures~~ 3 and 4, the base station BS exhibits further components and devices not shown. A corresponding transceiver device SEE and evaluating device AW ~~can~~ also can be implemented in the mobile radio station MS.

For illuminating a radio coverage area, the base station BS is connected to an antenna device which consists, for example, of three individual radiators. Each of the individual radiators beams into a sector of the radio coverage area covered. Alternatively, however, a larger number of individual radiators ~~can~~ also can be used (in accordance with adaptive antennas) so that a spatial subscriber separation is also made possible in accordance with a SDMA (Space Division Multiple Access) method.

An exemplary frame structure of the radio interface can be seen in Figures ~~figure~~ 2. According to a TDMA component, a division of a broadband frequency band, for example with a bandwidth B = 5 Mhz, into a number of time slots ts, for example 16 timeslots ts0 to ts15, is provided. Each time slot ts within the frequency band B forms one frequency channel fk. Within a broadband frequency band B, the successive time slots ts are structured in accordance with a frame structure. Thus, 16 time slots ts0 to ts15 are combined to form a frame.

When using a TDD transmission method, some of the time slots ts1 to ts15 are used in the up link

and some of the time slots ts0 to ts15 are used in the down link, the transmission in the up link taking place, for example, before the transmission in the down link. Between these, there is a switching time SP which can be flexibly positioned in accordance with the respective demand for transmisison channels for the up link and down link. A frequency channel fk for the up link corresponds to the frequency channel fk for the down link in this case. The other frequency channels fk are structured in the same manner.

Within the frequency channels fk, information from a number of connections is transmitted in message blocks. These message blocks consist of sections with data d in which, in each, case sections with training sequences tseq1 to tseqn, known at the receiving end, are embedded ~~in each case~~. The data d are spread individually for each connection with a fine structure, a spread-spectrum code c (CDMA code) so that, for example, n connections can be separated by this CDMA component at the receiving end. The combination of a frequency channel fk and a spread-spectrum code C defines a transmission channel RU which can be used for transmitting signaling and user information.

The spreading of individual symbols of the data d with Q chips has the effect that Q subsections with a period tchip are transmitted within the symbol period tsym. The Q chips form the individual CDMA code c. Furthermore, a guard period gp is provided within the time slot ts for compensating for different signal transit times of the connections of successive time slots ts.

It is, also possible to use the method according to the present invention, for example, for a known CDMA subscriber separation method in which a transmission channel RU is only defined by a frequency band B and a CDMA code

and user and signal information is ~~are~~ continuously transmitted in the transmission channels.

Figures 3 and 4 show signaling diagrams for, in each case, an exemplary embodiment of the method according to the present invention. A mobile radio station MS attempts to set up a connection, referring to the radio communication system of FIGURE ~~figure~~ 1. This is done, for example, in the manner known from the GSM mobile radio system that the mobile radio station MS monitors a general signaling channel BCCH, in which general information about the mobile radio system is periodically transmitted and which is transmitted in parallel by all base stations BS, and initiates a connection setup to the base station BS, the signaling channel BCCH of which it receives with the greatest received level. As a rule, this is base station BS in the radio coverage area of which the mobile radio station MS is currently located. According to the structure of the radio interface shown in FIGURE ~~figure~~ 1, the general signaling channel BCCH can be sent by the base stations BS, for example, in the first time slot ts0, distinguishability of the various base stations BS being ensured by a different training sequence tseq.

As specified in FIGURE ~~figure~~ 3, the mobile radio station MS determines, for example, the received level RXLEV with which it is receiving the general signaling channel BCCH. Only the base station BS is shown in the radio coverage area of which the mobile radio station MS is currently located and the general signaling channel BCCH of which it is receiving with the greatest received level. As an alternative, the mobile radio station MS ~~can~~ also can determine a characteristic value which contains information on a received level RXLEV, a bit error

rate and/or a value proportional to the signal transit time between the base station BS and the mobile radio station MS and/or a signal/noise ratio. However, the examples in Figures ~~figures~~ 3 and 4 only relate to the determination of the received level RXLEV.

The mobile radio station MS transmits the received level RXLEV determined, together with the request for connection set-up, to the base station BS in a signaling channel RACH. The basic structure of the signaling channel RACH can correspond to the random access channel (RACH) known from the GSM mobile radio system and which is used by the mobile radio stations MS for random multiple access according to the principle of the slotted-aloha method. In this method, the mobile radio station MS requests a dedicated signaling channel SDCCH (Stand Alone Dedicated Control Channel) which is exclusively allocated to the respective mobile radio station MS. In such a specific signaling channel SDCCH, the mobile radio station MS can perform, for example, a more accurate specification of the number of transmission channels RU needed for the communication connection V to be set up. It is also conceivable, and shown in this manner in Figure ~~figure~~ 3, that the mobile radio station MS directly specifies the number of transmission channels RU needed in the signaling channel RACH.

The base station BS evaluates the content of the signaling channel RACH, i.e. the number of transmission channels RU needed and the received level RXLEV, in an evaluating device AW connected to the transceiver device SEE. After the evaluation, the requested transmission channels RU are allocated to a further signaling channel AGCH which can correspond to an expanded signaling channel AGCH (Access Grant Channel), known from the GSM mobile radio system for acknowledging the allocation. The transmitting power of the further signaling channel AGCH

is controlled on the basis of the evaluated signaling channel RACH, secure reception of the signaling channel RACH being given at the location of the requesting mobile radio station MS. The transmission channels RU are allocated by specifying the CDMA codes C1, C4 which are then used by the mobile radio station MS for transmitting and receiving user and signaling information. The sending of the further signaling channel AGCH advantageously does not result in any impairment of the quality of reception for the further mobile radio stations MS which have set up a communication connection V1, V2 in the same frequency band. This is of great significance, especially in the CDMA subscriber separation method described, since the signals actually transmitted can no longer be filtered out in the receiving mobile radio station MS if the background noise is too high.

The signaling diagram shown in Figure ~~figure~~ 4 deals with a special feature, in the exemplary use of the method according to the present invention in a radio communication system having both a CDMA and a TDMA subscriber separation, the structure of which is shown in Figure ~~figure~~ 2. In comparison with the known GSM mobile system in which only one transmission channel RU is available in each time slot ts, a number of transmission channels RU can be used in parallel in a frequency band B and time slot ts for communication connections V with this structure of the radio interface. The case can thus occur that a number of mobile radio stations MS are, in each case, allocated at one or more transmission channels RU in one time slot ts. In the GSM mobile radio system, transmission channels RU are allocated to mobile radio stations MS without considering interference and other disturbance phenomena prevailing ~~in each case~~ in a time slot ts. Since this interference, which can very severely impair the quality of reception of the mobile radio station ~~MS~~

is dependent on the location of the mobile radio station MS, the mobile radio station MS additionally determines the respective interference conditions in the time slots ts before attempting to set up a connection.

The respective interference conditions can be given, for example, a weighting factor in the mobile radio station MS and this weighting factor can be transmitted to the base station BS in the signaling channel RACH. The evaluating device AW in the base station BS controls the allocation of the requested transmission channels RU, identified by two CDMA codes C1 and C4 in time slots ts1 and ts2, respectively, on the basis of the interference measurements by the mobile radio station MS, the transmission channels RU being advantageously allocated in one or more time slots ts in which the most advantageous interference situation is given for the mobile radio station MS. This advantageously improves the quality of transmission within the entire radio coverage area of the base station BS.

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